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THE RATE OF EXTINCTION IN MAZE-BRIGHT AND
MAZE-DULL RATS

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THE RATE OF EXTINCTION IN MAZE-BRIGHT AND MAZE-DULL RATS^{1, 2}

BY W. T. HERON and B. F. SKINNER
University of Minnesota

A given level of performance on a trial and error problem cannot at the present time be attributed to any one aspect of the learning process. Two strains of animals differentiated with respect to their scores on a maze cannot, without further analysis, be said to differ specifically in sensory acuity, motor ability, rate of learning, or any other single process or capacity. One method of identifying the source of the difference is to compare the performances of the two strains in a second learning situation which overlaps the first at only one point or at as few points as possible. If the same difference is observed, then the source must be common to the two situations; if not, it must be peculiar to the first.

In the present experiment strains of rats which had been separated on the basis of scores in a linear multiple-T maze were studied in their response to a lever, the pressing of which was at some time reinforced with food. In particular the rate of extinction of the response following periodic reinforcement was utilized. If we assume that an important part of the behavior in the maze involves the dropping out (extinction) of "wrong" responses, and if the two strains of rats differ in the rate at which responses are dropped out, then a difference should be observed in the present situation. It is true that in the maze "wrong" responses are made in the presence of stimuli which must be discriminated, but it has been shown that the elimination of the unreinforced member of a pair of responses to discriminated stimuli follows the same general curve as simple extinction (5).

The experiment is designed to lead to one or the other of these conclusions: Either (a) the strains differ significantly in the rate

¹ The authors are grateful to the National Youth Administration for help on the preparation of the data in this experiment.

² Recommended for publication by Dr. C. M. Louttit, April 9, 1940.

of extinction, in which case the difference in maze performance may to that extent be identified as a difference in the process of extinction; or (b) the strains do not differ significantly, and hence the difference in maze performance must be attributed to other factors, such as sensory acuity, motor patterns or preferences, motivation, and so on.

SUBJECTS AND TECHNIQUE

Four groups of the F_{14} rats selectively bred with respect to maze performance were used (2) (3). The animals are described in Table 1. It will be seen that the groups are progressively more widely differentiated with respect to maze performance in the order given. The first two groups, although containing animals belonging genetically to different strains, are not significantly different in their own scores. The last two groups show a wide difference.

The apparatus has been described elsewhere (4). It permits the simultaneous investigation of twenty-four rats, for which individual curves and mechanically averaged curves for the group and for subgroups are available. The animals were put on a feeding routine for several days to establish a hunger-rhythm and were then given the usual preliminary training in the apparatus. After several days of periodic reinforcement for one hour at four-minute intervals, extinction was carried out. Records one hour long for five days were obtained.

RESULTS

A comparison of the rates of responding maintained by the two groups under periodic reinforcement is important for several reasons. Such a rate has been shown to vary with the condition of feeding (5) and hence to serve as a convenient measure of degree of hunger. Whether the strains differ in degree of hunger when maintained on a common feeding routine is in itself an important question. (Since the rate varies with other conditions as well, it is only an assumption that differences thus obtained are due to hunger, but it is perhaps the best assumption under the circumstances.) The principal reason for examining this rate is that the

process of extinction begins at the level of activity maintained under periodic reinforcement, and any group difference in responding during extinction must first be referred to a possible difference in initial level.

The data on this point are presented in Table 2. A difference of 64 responses per hour in favor of a greater hunger for the bright group is shown. If we take the rate as a direct measure of hunger, the hunger of the bright rats exceeded that of the dull by about 31%. It is not, of course, proved thereby that this is a difference in hunger alone, but it is at least the kind of difference that can be produced experimentally by modifying the procedure of feeding and fasting. Although individual rates vary considerably, these group means are significant. The difference is 3.47 times the standard deviation. This confirms a previous result obtained by Harris (1).

A comparison of the group means during extinction is given in Table 3. Here again the bright rats respond at a higher rate, although a significant difference is observed for the first three days only. We should expect this result from the difference in rate at which the two groups begin the process of extinction, and if we allow for this original difference, the experiment shows no significant difference in performance between the groups during the process of extinction. It would appear that the only difference is in the degree of hunger arising from the plan of feeding.

If we consider only the absolute drop in rate during extinction, we may say that the bright rats extinguish more rapidly. This is shown by the disappearance of the significant difference between the groups as the process continues. However, the inspection of any group of extinction curves will show that the rates observed during extinction are a function of the initial rate, which differed for the groups in this experiment. A more significant way to compare the present groups is to express the rate during extinction as a percentage of the rate during periodic reinforcement. This is equivalent to multiplying the data for one group by a correction factor chosen to equate the rates under periodic reinforcement. (The use of such a factor is in harmony with the assumption that the rate of responding during extinction is proportional to the degree of hunger.) In Figure 1 the extinction curves for the four

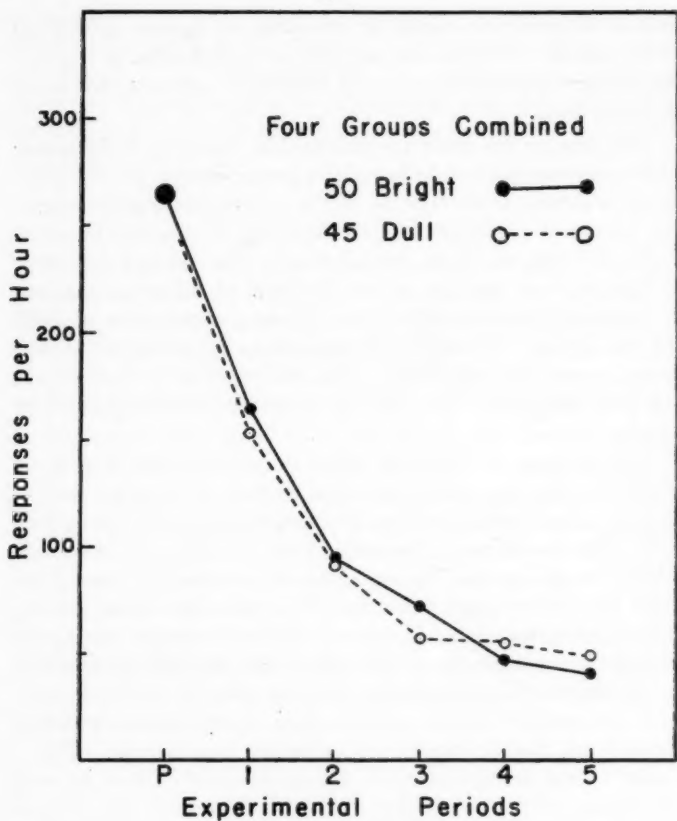


FIGURE 1

Extinction Curves of the Four Experimental Groups

The open circles represent points which have been corrected for differences in the rate under the preceding periodic reinforcement. The original values are indicated (x, x...).

experimental groups are plotted in the form of number of responses per hour against hourly periods. A correction factor has been applied to each set of data for the dull rats, but the uncorrected

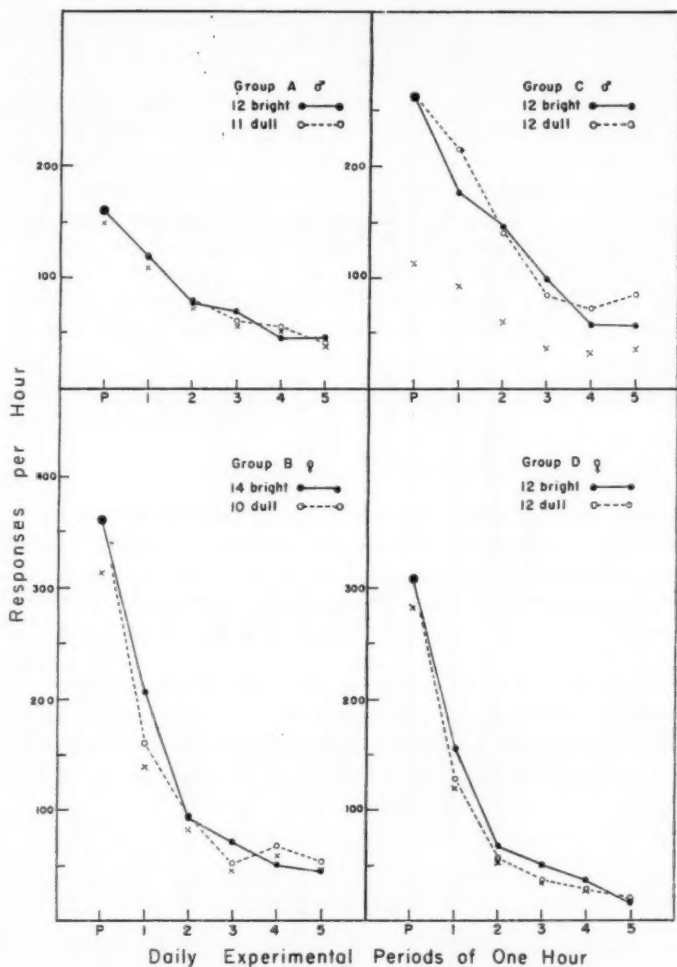


FIGURE 2

Extinction Curves for Bright and Dull Rats

The rates have been corrected for differences in rate obtaining under periodic reinforcement prior to extinction.

TABLE 1
DESCRIPTION OF THE EXPERIMENTAL GROUPS

Group	A	B	C	D
Number	12 bright 11 dull	14 bright 10 dull	12 bright 12 dull	12 bright 12 dull
Sex	male	female	male	female
Age at start of experiment	6 mo.	6½ mo.	7 mo.	8 mo.
Mean error score in maze:				
Bright	89.5	81.69	51.91	58.08
Dull	88.09	84.33	101.25	121.41
Days on periodic reinforcement	6	5	3	4
Days of extinction	5	5	5	5

data are indicated in the graphs (x). The first point in each curve (at P) gives the average rate obtaining under periodic reinforcement for three days prior to extinction. The bright and dull groups correspond exactly at this point because of the correction.

In Figure 2 all four groups have been combined to present the result for the whole experiment.

Although the curves in Figure 1 show no difference between the bright and dull rats which is not attributable to a difference in drive, the possibility of considerable variation in this respect is indicated. All four groups show a difference in the same direction, but it is Group C which contributes the greater part of the difference between the means for the combined groups. In addition the figure shows certain differences between the experimental groups. In general the females maintain a higher level of hunger, the exception being the bright males in Group C.

SUMMARY AND CONCLUSIONS

In two out of four groups differences in the raw data show a greater number of responses during five hours of extinction for bright rats. In the other groups there is no significant difference. Where a difference occurs, it is probably due to the greater degree of hunger developed by the bright rats under the feeding routine used.

In so far as the extinction of "wrong" responses is accepted as an important part of maze learning, the experiment indicates that strains of rats selectively bred for maze performance are not necessarily separated on the basis of a central learning process.

TABLE 2
THE MEAN RATE OF RESPONDING UNDER
PERIODIC REINFORCEMENT

	N	Mean	S.D. _m
Bright	50	269	7.4
Dull	45	205	17.0

TABLE 3
THE MEAN RATE OF RESPONDING DURING
EXTINCTION

Day	Bright		Dull		D	S.D.	D
	Mean	S.D.	Mean	S.D.			S.D.
1	163	10.6	110	6.7	53	12.4	4.3
2	92	7.8	64	4.6	28	8.8	3.2
3	71	6.4	43	3.6	28	7.3	3.8
4	46	4.3	39	3.9	7	5.7	1.2
5	39	5.0	32	3.6	7	6.0	1.2

REFERENCES

1. Harris, Robert E., "An Analysis of the Maze-Learning Scores of Bright and Dull Rats with Reference to Motivational Factors." (in press)
2. Heron, W. T., "Inheritance of Maze-Learning Ability in Rats," *J. Comp. Psychol.*, 1935, 19:77-89.
3. Heron, W. T., "The Inheritance of Brightness and Dullness in Maze-Learning Ability in the Rat," *Jour. Genet. Psychol.* (in press)
4. Heron, W. T., and Skinner, B. F., "An Apparatus for the Study of Animal Behavior," *Psychol. Record*, 1939, 3, 166-176.
5. Skinner, B. F., *The Behavior of Organisms*. New York: Appleton-Century, 1938.

